



SOUTH CAROLINA GRID IMPROVEMENT PLAN PROGRAM SUMMARIES

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PROGRAM: INTEGRATED VOLT/VAR CONTROL (IVVC)



The IVVC program establishes control of distribution equipment in substations and on distribution lines to optimize delivery voltages to customers and power factors on the distribution grid.

DESCRIPTION

IVVC allows the distribution system to optimize voltage and reactive power needs. The program employs remotely operated substation and distribution line devices such as voltage regulators and capacitors. The settings for thousands of these controllable field devices are optimized and dispatched via a distribution management system.

IVVC capabilities enable a grid operator to lower voltage as a way of reducing peak demand (peak shaving), thereby reducing the need to generate or purchase additional power at peak prices, or protecting the system from exceeding its load limitations. The current DEP **Distribution System Demand Response (DSDR)** program uses the peak shaving mode of IVVC to support emergency load reduction.

Another operational mode enabled by IVVC capabilities on the distribution system is **Conservation Voltage Reduction (CVR)**. CVR uses IVVC during periods of more typical electricity demand to reduce overall energy consumption and system losses.

GRID CAPABILITIES ENABLED

- ✓ INCREASE MONITORING & VISIBILITY
- ✓ INCREASE AUTOMATION
- ✓ INCREASE DISTRIBUTED INTELLIGENCE
- ✓ ENABLE VOLTAGE CONTROL
- ✓ ACCOMMODATE TWO-WAY POWER FLOWS
- ✓ INCREASE HOSTING CAPACITY
- ✓ MODERNIZE GRID OPERATIONS & PLANNING

VALUE TO OUR CUSTOMERS

- ✓ MAINTAIN REASONABLE RATES
- ✓ IMPROVE RELIABILITY, SAFETY, RESILIENCY
- ✓ MEET OR EXCEED CUSTOMER EXPECTATIONS

WHERE IT FITS IN OUR PLAN

OPTIMIZE the total customer experience

PROGRAM: INTEGRATED VOLT/VAR CONTROL (IVVC)



MORE ABOUT THE PROGRAM

The Distribution Management System (DMS), which manages the dispatch of IVVC functionality, can be designed to manage distribution circuits such that any impacts to customers with large motors sensitive to voltage control can be reduced. To maximize operational flexibility and value, the IVVC system can also have peak shaving capability and emergency modes of operation. Advanced DMS software upgrades will enable IVVC to operate in various modes to provide further customer benefit in the future.

DSDR to CVR in DEP

In 2014, Duke Energy implemented DSDR in DEP, achieving peak shaving voltage reduction of approximately 3.6% across the DEP distribution system. The DMS in DEP is capable of optimized modes (i.e., DSDR) or non-optimized (i.e., emergency) modes. When in emergency mode, the system can quickly provide a temporary voltage reduction capability of up to 5.0%.

DEP's initial implementation of DSDR also included a significant amount of circuit conditioning to optimize the system for DSDR mode (i.e., the installation of voltage regulating devices and capacitors, balancing of load on distribution circuits, and reconductoring of some distribution lines to larger wire sizes).

Because the substation, distribution, telecommunications, and IT infrastructure were put in place as part of the original DSDR implementation, this sub-program focuses on the deployment of the few additional device installations as well as the DMS upgrades required to support various operational modes, including the current DSDR mode and CVR mode, as well as Self Optimizing Grid and other distribution automation capabilities.

Through this sub-program, Duke Energy will enable 2% voltage reduction for energy conservation (an average of roughly 1.4% load reduction).

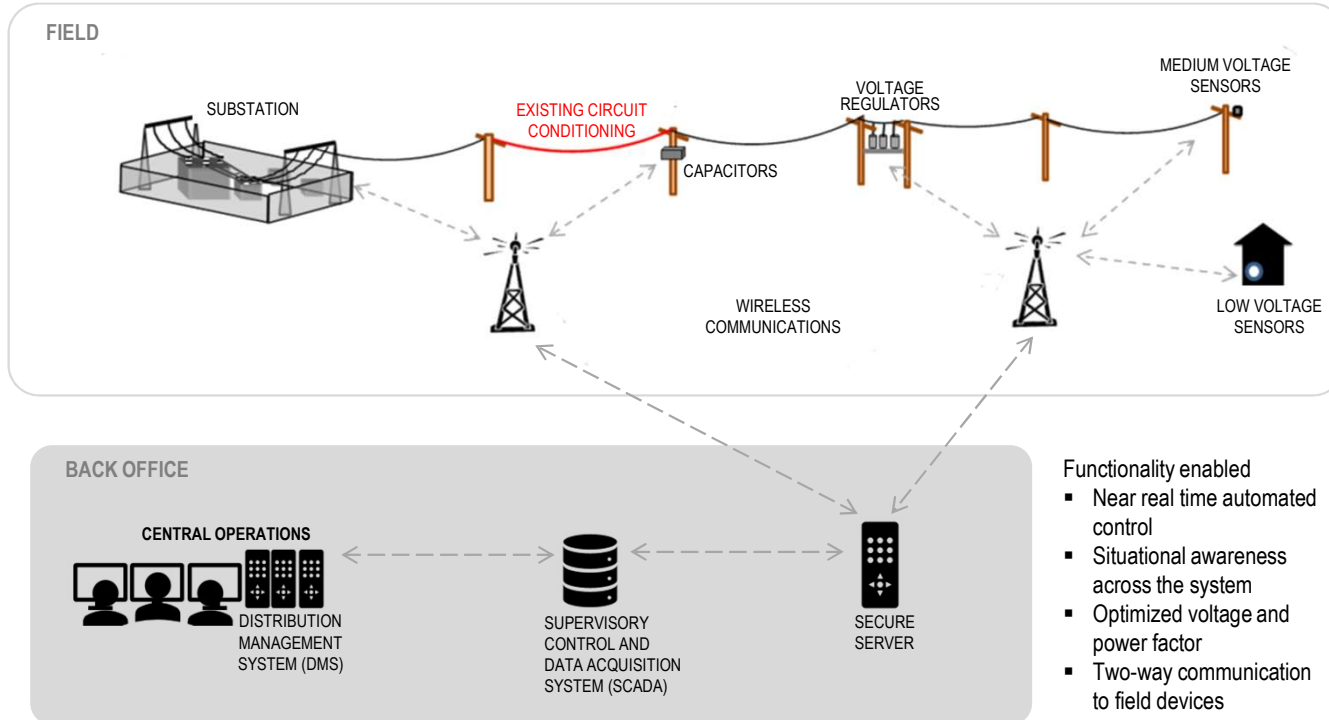
IVVC Project in DEC

The DEC IVVC pre-scale deployment project used real-time field conditions on a small scale to demonstrate the use of IVVC on the DEC system, and validate benefits in advance of its full-scale rollout. The small-scale demonstration validated voltage reductions of approximately 2% are possible with appropriate transmission and distribution system upgrades.

The DEC IVVC project will install communications and voltage control infrastructure at substations and associated distribution lines. The project will also leverage overlaps with efforts like Self Optimized Grid projects that deploy some of the infrastructure and capabilities necessary to enable IVVC.



PROGRAM: INTEGRATED VOLT/VAR CONTROL (IVVC)



SMART CAPACITOR BANK





PROGRAM: SELF-OPTIMIZING GRID (SOG)

The self-optimizing grid program, also known as the smart-thinking grid, redesigns key portions of the distribution system and transforms it into a dynamic self-healing network.

DESCRIPTION

The current grid has limited ability to reroute or rapidly restore power and limited ability to optimize for the growing penetrations of distributed energy resources (DER). The SOG program is established to address both of these issues.

The SOG program consists of three (3) major components: grid capacity, grid connectivity, and automation and intelligence. The SOG program redesigns key portions of the distribution system and transforms it into a dynamic smart-thinking, self-healing grid. The grid will have the ability to automatically reroute power around trouble areas, like a tree on a power line, to quickly restore power to the maximum number of customers and rapidly dispatch line crews directly to the source of the outage. Self-healing technologies can reduce outage impacts by as much as 75 percent.

The **SOG Capacity projects** focus on expanding substation and distribution line capacity to allow for two-way power flow. **SOG Connectivity projects** create tie points between circuits. **SOG Automation projects** provide intelligence and control for the Self Optimizing Grid. Automation projects enable the grid to dynamically reconfigure around trouble and better manage local DER.

GRID CAPABILITIES ENABLED

- ✓ INCREASE MONITORING & VISIBILITY
- ✓ INCREASE AUTOMATION
- ✓ INCREASE DISTRIBUTED INTELLIGENCE
- ✓ IMPROVE RELIABILITY
- ✓ ACCOMMODATE TWO-WAY POWER FLOWS
- ✓ INCREASE HOSTING CAPACITY

VALUE TO OUR CUSTOMERS

- ✓ MAINTAIN REASONABLE RATES
- ✓ IMPROVE RELIABILITY, SAFETY, RESILIENCY
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WHERE IT FITS IN OUR PLAN

OPTIMIZE the total customer experience

PROGRAM: SELF-OPTIMIZING GRID (SOG)



MORE ABOUT THE PROGRAM

The SOG program, also known as the smart-thinking or self-healing grid, implements distribution system design guidelines that improve grid reliability and resiliency. SOG circuits will have automated switches to divide the circuit into switchable segments. Each segment is designed to consist of approximately 400 customers, three miles in circuit segment length, or serve 2MW of peak load. This design ensures that any issues on the system can be isolated, and customer impacts are limited. The long term vision is to serve 80% of customers by the Self-Optimizing Grid.

Advanced Distribution Management System (ADMS)

The ADMS subprogram is an enterprise-wide program to deploy a common distribution management system. Consolidating to a single platform for DMS and SCADA systems enables operational efficiency and the ability to integrate future solutions needed as demands on the distribution system evolve. The three main projects are: (1) **SCADA upgrade project** which upgrades the supervisory control and data acquisition system; (2) **DMS common platform project** which deploys a common version of DMS across DEC and DEP; and (3) **Closed loop FLISR project** which deploys DMS functionality that minimizes the area impacted by the resulting outage.

SOG Segmentation & Automation

This subprogram focuses on segmenting circuits in accordance with SOG design guidelines (segments should serve approximately 400 customers, are three miles in length or serve 2 MW of peak load) and equipping those segments with automated switching devices. The purpose is to limit the exposure of customers to power outages associated with faults on a line (e.g., a tree falling or vehicle-power pole collision). This is accomplished by sectionalizing a circuit by adding and/or re-configuring a number of protective devices on tap lines.

Circuit Capacity and Connectivity

This subprogram focuses on upgrading selected circuit feeders and tying them together to meet the SOG design philosophy. The circuit capacity activities involve upgrading the feeder conductor and voltage control devices to enable a circuit to carry its own customer load as well as portions of adjacent circuit customer load, as needed.

Substation Bank Capacity

This subprogram focuses on upgrading selected substations to meet the SOG design philosophy. The substation bank capacity activities involve upgrading existing substation transformers and other associated equipment to allow for a substation to service its normal customer load as well as any additional load it may pick up during a SOG isolation/reconfiguration event.

PROGRAM: POWER ELECTRONICS FOR VOLT/VAR



The Power Electronics program integrates protection and control technology, helps reduce power quality issues associated with high DER penetration, and ultimately improves reliability to customers.

DESCRIPTION

As the adoption of distributed energy resources (DER) (e.g., customer-owned solar and energy storage) reaches critical levels and microgrid technology matures, protective device technology must also advance to appropriately detect and respond to rapid voltage and power fluctuations that often accompany non-dispatchable resources such as solar.

As clouds move across the daytime sky and momentarily block sunlight from reaching solar panels, solar generation immediately ceases. As sunlight peaks through openings in the cloud cover, the solar panels begin generating, creating power spikes and voltage instability on the circuit. These intermittent power impacts occur and then change at rapid rates (in some cases sub-second) and frequently faster than the legacy electro-mechanical voltage management equipment like regulators and capacitors can handle.

Integrating advanced solid-state technologies like power electronics (i.e., static VAR compensators and other solid-state voltage support equipment), better equips the distribution system to manage power quality issues associated with increasing DER penetration.

The program is still in its early stages and current plans are small pre-scale deployments to validate capabilities and benefits.

GRID CAPABILITIES ENABLED

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- ✓ IMPROVE RELIABILITY
- ✓ ENABLE VOLTAGE CONTROL
- ✓ ACCOMMODATE TWO-WAY POWER FLOWS
- ✓ INCREASE HOSTING CAPACITY

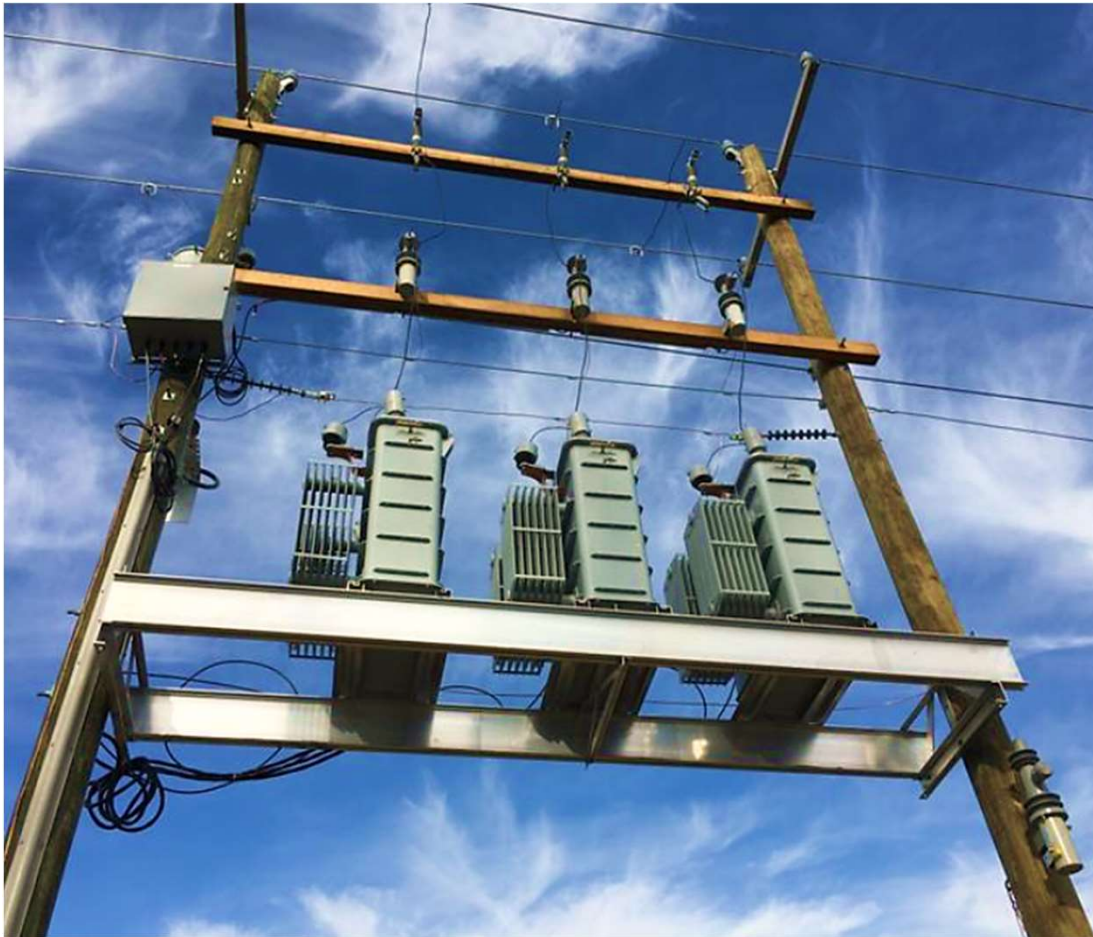
VALUE TO OUR CUSTOMERS

- ✓ MAINTAIN REASONABLE RATES
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WHERE IT FITS IN OUR PLAN

MODERNIZE by leveraging enterprise systems and technology advancements

PROGRAM: POWER ELECTRONICS FOR VOLT/VAR



FIRST INSTALLATION OF MINIDVAR IN DEP TERRITORY

COST-EFFECTIVE UPGRADE FOR
FEEDERS WITH HIGH SOLAR PV OR
DG GROWTH

PROGRAM: DISTRIBUTION SYSTEM AUTOMATION (DA)



The DA program improves how the distribution system protects the public and itself from unsafe voltage and current levels and significantly reduces the impact experienced by customers due to grid issues.

DESCRIPTION

The capabilities offered through DA can transform what may have been an hour-long power outage for hundreds or even thousands of homes and businesses into a momentary outage – or potentially help avoid an outage altogether.

The DA consists of several complementary efforts that work in concert to support dynamic and growing distribution system loads in a more sustainable way while minimizing power quality issues that often accompany a large-scale transition to solar power. One of these projects, **Urban Underground System Automation**, modernizes the protection and control of underground power systems that serve critical high-density areas, such as urban business districts and airports.

The **Fuse Replacement** project focuses on replacing one-time use fuses with automatic operating devices capable of intelligently resetting themselves for reuse, thus eliminating unnecessary use of resources (inventory, time, gasoline, etc.). The **Hydraulic to Electronic Recloser** program replaces obsolete oil-filled (hydraulic) devices with modern, remotely operated reclosing devices that support continuous system health monitoring.

Such digital device upgrades offer further value through efforts like the **System Intelligence and Monitoring** pilot, which develops advanced diagnostic tools that help engineers and technicians address electrical disturbances on the distribution system and improve customer experience.

GRID CAPABILITIES ENABLED

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WHERE IT FITS IN OUR PLAN

MODERNIZE by leveraging enterprise systems and technology advancements

PROGRAM: DISTRIBUTION SYSTEM AUTOMATION (DA)



MORE ABOUT THE PROGRAM

Through its suite of complementary efforts, the DA Program offers a way to deliver electricity to customers while avoiding preventable service interruption for thousands of customers.

Hydraulic to Electronic Recloser

Phases out existing hydraulic (oil-filled) reclosers to reduce the oil footprint and eliminate maintenance activities. The sub-program has two phases: (1) target all hydraulic reclosers rated 140 amps or greater and replace with electronic, solid-dielectric interrupter devices; and (2) focus on smaller hydraulic reclosers (those rated less than 100 amps) and replace them with similar electronic, solid-dielectric, reclosing devices as this technology becomes mature enough for full scale deployment.

System Intelligence and Monitoring Pre-Scale Effort

Leverages data from digital devices deployed as part of the Self-Optimizing Grid, Smart Meter, and other programs to build a database and system model that monitors electrical disturbances across the distribution system. While each grid device may only monitor a portion of a circuit, advanced analytics creates a larger picture of system activity and an end-to-end blended view of customer experience. When completed, this subprogram will create a new system diagnostic tool for troubleshooting problem areas and mitigating emerging issues as they occur, as well as for managing the integration of DER.

Fuse Replacements with Electronic Reclosers

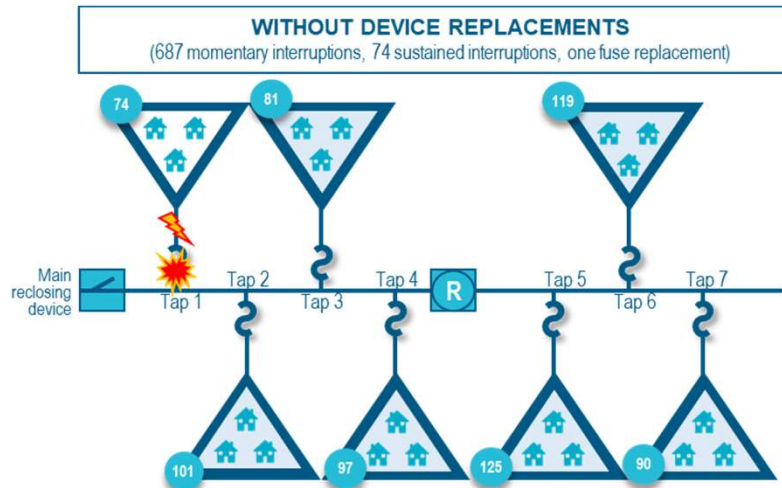
Replaces protective tap line fuses with small electronic sectionalizing devices on segments that can eliminate the most interruptions for customers. The small electronic reclosers serve to prevent customer outages by allowing temporary faults time to clear power lines before operating and initiating sustained outages. A protective fuse in this same tap line configuration is designed to actuate and initiate a sustained line outage at the first sign of a line fault; it must then be replaced before service can be restored. The fuse replacement with electronic recloser eliminates the mainline breaker from operating at all, eliminating unnecessary momentary interruptions and sustained outages.

Underground (UG) System Automation

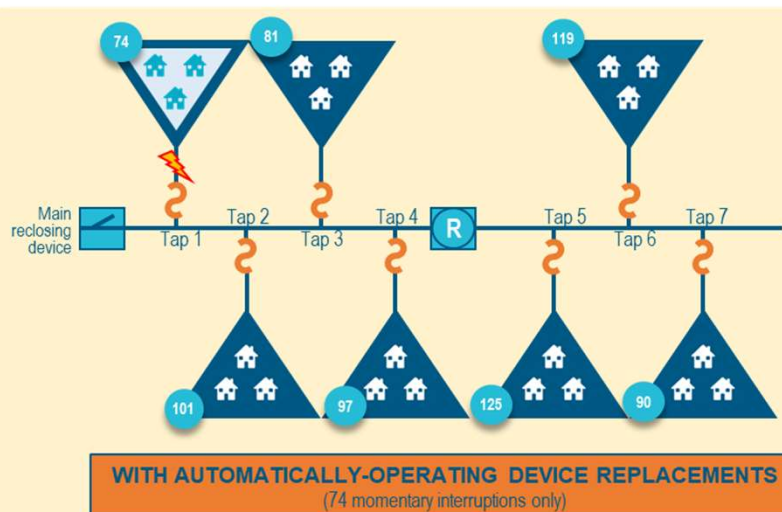
Replaces manually operated underground switchgear with remotely operated automated switchgear and deploys advanced automation schemes in urban downtown areas and other places with high density public use, such as airports and public entertainment areas. UG Automation enables automatic reconfiguration of underground systems for connecting to a new feeder or for isolating downstream system faults to minimize customer outages and impacts to the public. When completed, what might have been hours of service interruption can be reduced down to seconds.



PROGRAM: DISTRIBUTION SYSTEM AUTOMATION (DA)



- Temporary fault Tap 1
- Main reclosing devices blinks
- All **687** customers experience a **momentary outage**
- The **74** customers of neighborhood 1 experience a **sustained outage** until the Tap 1 fuse is replaced



- Temporary fault Tap 1
- Main reclosing devices blinks
- Only the **74** customers experience a **momentary outage**
- Auto-operating device resets
- **Zero sustained outages**; no fuse replacement needed



PROGRAM: ENERGY STORAGE

The Energy Storage program implements battery storage and other related non-traditional measures to defer, mitigate, or eliminate the need for traditional utility investments, such as line capacity upgrades.

DESCRIPTION

The program supports customer and utility initiatives through smart investments in storage for applications that deliver value to customers and the company. These applications include microgrid projects for preventing planned and unplanned outages, as well as long-duration outage projects for providing redundant power sources for vulnerable (rural and remote) communities, and circuit and bank capacity projects using substation-tied energy storage.

Given the multiple applications energy storage technology supports, projects within the Energy Storage program are designed and assessed on a case-by-case basis for the specific challenge being addressed (e.g., long duration outage support, microgrid or emergency power support, auxiliary service needs, etc.).

The Energy Storage program also includes the development and deployment of an energy storage control system to manage the fleet of energy storage resources.

GRID CAPABILITIES ENABLED

- ✓ IMPROVE RELIABILITY
- ✓ INCREASE DISTRIBUTED INTELLIGENCE
- ✓ ENABLE VOLTAGE CONTROL
- ✓ ACCOMMODATE TWO-WAY POWER FLOWS
- ✓ INCREASE HOSTING CAPACITY (DER Enablement)
- ✓ MODERNIZE GRID OPERATIONS & PLANNING
- ✓ EXPAND CUSTOMER OPTIONS AND CONTROL

VALUE TO OUR CUSTOMERS

- ✓ MAINTAIN REASONABLE RATES
- ✓ IMPROVE RELIABILITY, SAFETY, RESILIENCY
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WHERE IT FITS IN OUR PLAN

OPTIMIZE the total customer experience

PROGRAM: ENERGY STORAGE



MORE ABOUT THE PROGRAM

Energy storage provides several different forms of value when applied to the distribution grid. It can be used as a tool to improve reliability to remote communities and it can help increase the how much DER in the form of solar energy can be connected to the grid. It can also be used as a way to delay or mitigate the need to invest in more traditional resources to address transmission and distribution capacity needs.

Energy Storage Control System (ESCS)

By enabling grid operators to dispatch batteries, and batteries plus solar, as part of a diverse generation portfolio, the ESCS project creates the means for distributed energy resources to provide a more cost-effective, energy storage solutions for enhancing grid efficiency and reliability, along with bulk power operations effectiveness. The primary ESCS applications include: (1) Frequency regulation services, (2) Energy arbitrage (i.e., shifting to charge off-peak, discharge-on peak), and (3) Microgrid islanding for outage support and peak shaving.

Interrelation with Integrated System Ops Planning (ISOP)

Energy storage is a technology that offers the ability to support many valued requirements across the generation, transmission and distribution systems. The Integrated System Operation Planning (ISOP) effort will enable storage and microgrid projects to be deployed more effectively.

Example: Mt. Sterling Microgrid

The Mt. Sterling Microgrid project was developed to provide electric service to a remote customer in a reliable but more cost-effective way than via a traditional distribution feeder. The microgrid option meets customer needs through use of distributed energy resources, while enhancing both safety and productivity for utility workers by mitigating line maintenance activity in a high-risk, labor-intensive environment. With the maturity of energy storage technology, a microgrid with solar and storage components sized to support customer load for seven consecutive days (without solar generation) was designed, assessed, and determined to be a more reliable and cost effective option for meeting the customer's need for service. The solution, a 10-kW solar PV array, a 95-kWh battery energy storage system and remote monitoring system, offers availability 99.95% of time, with 25-year asset life.

PROGRAM: ENERGY STORAGE



MCALPINE MICROGRID BATTERY SYSTEM



COMMUNITY BATTERY
BACKUP SYSTEM



NOTREES BATTERY STORAGE FACILITY



PROGRAM: LONG DURATION INTERRUPTION / HIGH IMPACT SITES (LDI/HIS)



The LDI/HIS program is designed to improve the reliability for parts of the grid with high potential for long duration outages as well as for high-impact customers like airports and hospitals.

DESCRIPTION

The LDI/HIS program is designed to improve the reliability in parts of the grid where the duration of potential outages is expected to be much higher than average. Focus areas for this program are radial feeds to entire communities or large groups of customers as well as inaccessible line segments (i.e. off road, swamps, mountain gorges, extreme terrain, etc.).

Many of the areas served by these long, rural, single-sourced feeders can experience significant impacts to the local economy and to quality of life when the entire town loses power. Further, operational and repair costs are generally higher than average in these areas due to the special equipment required.

While some sites may include extreme hardening, circuit relocations, new circuit ties and undergrounding, energy storage solutions may offer more cost-effective solutions for improving reliability and managing costs.

The LDS/HIS program is designed to improve the reliability of high- impact customers like airports and hospitals, and high-density areas that could require a variety of infrastructure solutions to improve power quality and reliability. Typical projects include substation upgrades, circuit ties, voltage conversions, and reconductoring.

GRID CAPABILITIES ENABLED

- ✓ IMPROVE RELIABILITY
- ✓ HARDEN FOR RESILIENCY

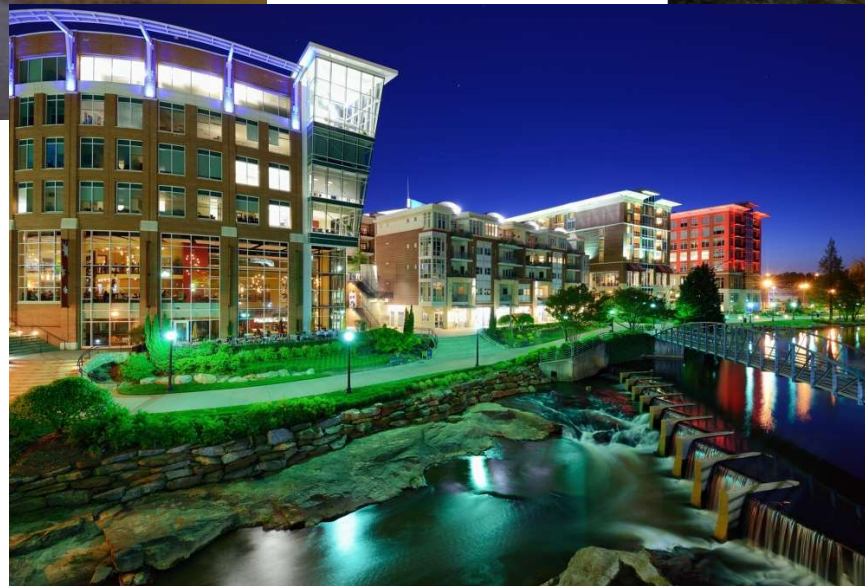
VALUE TO OUR CUSTOMERS

- ✓ MAINTAIN REASONABLE RATES
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WHERE IT FITS IN OUR PLAN

OPTIMIZE the total customer experience

PROGRAM: LONG DURATION INTERRUPTION / HIGH IMPACT SITES (LDI/HIS)



DOWNTOWN GREENVILLE, SC

PROGRAM: INTEGRATED SYSTEM OPERATIONS PLANNING (ISOP)



The ISOP program integrates utility planning for generation, transmission, distribution, and customer programs to improve the valuation and optimization of energy resources across the system.

DESCRIPTION

Requirements for modern electric utility systems are evolving rapidly with the advent of emerging new energy technologies, changes in policy, and rapid advancements in information exchange and customer needs. Integrated System Operations Planning (ISOP) focuses on the integration of utility planning disciplines for generation, transmission, distribution and customer programs to improve the valuation and optimization of energy resources across all segments of the utility system to best serve electric customers.

The ISOP process addresses key operational and economic considerations across all segments of the system through integration and refinement of existing system planning tools and, in some cases, development of new analytical tools to assess characteristics that have not historically been captured or considered in long-term planning. Some examples include locational values for distributed resources, system ancillaries and reserves needed to support future operations, and energy resource flexibility to support new dynamic operational demands on the system.

ISOP is a multi-year development program to build the tools and processes needed to accommodate an increasingly integrated approach that will be required to optimize planning and operation of the electric utility system of the future.

GRID CAPABILITIES ENABLED

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- ✓ INCREASE DISTRIBUTED INTELLIGENCE
- ✓ IMPROVE RELIABILITY
- ✓ ENABLE VOLTAGE CONTROL
- ✓ ACCOMMODATE TWO-WAY POWER FLOWS
- ✓ INCREASE HOSTING CAPACITY

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WHERE IT FITS IN OUR PLAN

MODERNIZE by leveraging enterprise systems and technology advancements

PROGRAM: TARGETED UNDERGROUNDING (TUG)



The TUG program strategically identifies Duke Energy's most outage prone overhead power line sections and relocates them underground to reduce the number of outages experienced by customers.

DESCRIPTION

Overhead power line segments with a history of unusually high numbers of outages drive a disproportionate amount of momentary interruptions and outages that affect Duke Energy's customers. When these segments of lines fail, they cause problems for Duke Energy's customers directly served by them as well as customers upstream. Lines targeted to be moved underground are typically the most resource-intensive parts of the grid to repair after a major storm. Equipment on these line segments can experience shortened equipment life and additional equipment-related service interruptions.

The goal of the TUG program is to maximize the number of outage events eliminated. Converting outage prone parts of the system enables Duke Energy to restore service more quickly and cost effectively for all customers. Addressing areas with outlier outage performance improves service while lowering maintenance and restoration costs for all customers.

Criteria for consideration in the selection of targeted communities include:

- Performance of overhead lines
- Age of assets
- Service location (e.g., lines located in backyard where accessibility is limited)
- Vegetation impacts (e.g., heavily vegetated and often costly and difficult to trim)

GRID CAPABILITIES ENABLED

- ✓ IMPROVE RELIABILITY
- ✓ HARDEN FOR RESILIENCY
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VALUE TO OUR CUSTOMERS

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WHERE IT FITS IN OUR PLAN

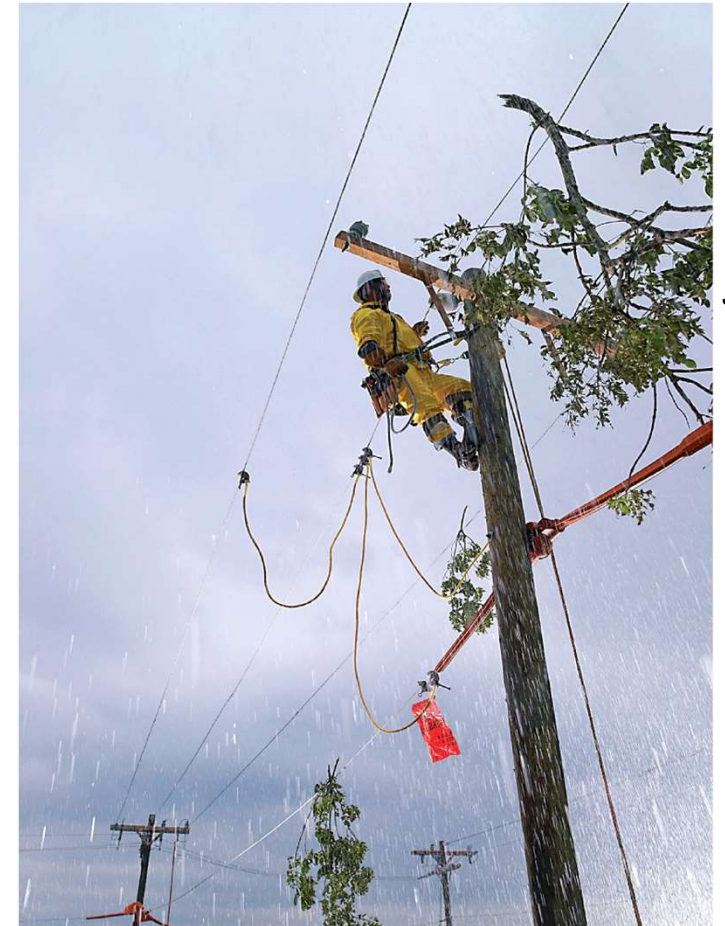
OPTIMIZE the total customer experience

PROGRAM: TARGETED UNDERGROUNDING (TUG)



**DOWNED POWER
POLES**

DAMAGE FROM
HURRICANE MATTHEW



LINEMAN IN RAIN
IN AREAS INACCESSIBLE BY BUCKET TRUCK,
LINEMEN HAVE TO CLIMB POLES TO MAKE REPAIRS

PROGRAM: DISTRIBUTION TRANSFORMER RETROFIT



The Distribution Transformer Retrofit program converts existing overhead distribution transformers to deliver the same reliability benefits as a modern transformer installed today.

DESCRIPTION

Like the Self-Optimizing Grid program, the new sectionalization capability of a retrofitted transformer works to minimize the number of customers impacted by fault or failure on the power line. In addition, similar to the Targeted Undergrounding program, the new protective features that mitigate equipment vulnerabilities work to significantly lower the risk of an outage occurring at the transformer all together.

The core activities of the transformer retrofit program include the installation of a fuse disconnect device on the high-voltage side of every overhead transformer to protect upstream customers from a fault at or downstream of the transformer. In addition, through protective device coordination, the local fused disconnect can be set to prevent any upstream operations of reclosing devices (the source of momentary outages for customers not served by the retrofitted transformer.)

Consistent with modern transformer standards, the program also retrofits transformers with additional protective elements to reduce the risk of external factors such as lightning strikes and animal interference.

GRID CAPABILITIES ENABLED

- ✓ IMPROVE RELIABILITY
- ✓ MODERNIZE GRID OPERATIONS & PLANNING

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WHERE IT FITS IN OUR PLAN

OPTIMIZE the total customer experience

PROGRAM: DISTRIBUTION TRANSFORMER RETROFIT



UN-RETROFITTED CSP TRANSFORMER



RETROFITTED TRANSFORMER

FUSED CUTOUT, ANIMAL GUARDS,
COVERED LEAD WIRE, NEW ARRESTER.



PROGRAM: DISTRIBUTION HARDENING & RESILIENCY – FLOOD HARDENING



The Distribution H&R – Flood Hardening program will be targeted to areas where an overlay of actual outage events from Hurricanes Matthew and Florence intersect with the 100-year flood plan.

DESCRIPTION

In hurricane events like Hurricane Floyd and more recently Hurricanes Matthew and Florence, significant flooding was a major factor impacting restoration. Smart, targeted investments can mitigate the scale of impacts on communities and customers adjacent to these areas prone to extreme flooding. Hardening lines and structures is a balanced approach that can keep power and critical services available to some portion of a community and prevent a widespread outage in an area until flooding recedes.

This program includes the following:

- Alternate power feeds for substations in flood-prone areas, and for radial power lines that cross into and through flood-prone areas
- Hardened river crossings where power lines are vulnerable to elevated water levels during extreme flooding
- Improved guying for at-risk structures within flood zones

GRID CAPABILITIES ENABLED

- ✓ IMPROVE RELIABILITY
- ✓ HARDEN FOR RESILIENCY
- ✓ IMPROVE PHYSICAL SECURITY

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WHERE IT FITS IN OUR PLAN

OPTIMIZE the total customer experience

PROGRAM: DISTRIBUTION HARDENING & RESILIENCY – FLOOD HARDENING



MORE ABOUT THE PROGRAM

Data analytics and geo-spatial analysis will assist Duke Energy in identifying patterns of repeat flood impact issues and allow a targeted basis for assessing hardening investments with a cost benefit analysis approach that delivers savings to Duke Energy customers and, at the same time, enhanced reliability for these flood-prone areas.

For a three-year window, this program will focus on hardest hit flood-prone areas from Hurricanes Matthew and Florence, defining opportunities to accomplish the following:

- Event elimination where hardening can demonstrably eliminate future outages events and repair work
- Resiliency options to re-route power and keep many people supplied with power while repairs to damaged facilities are made.

This program will be coordinated with other programs to ensure work scopes do not overlap.

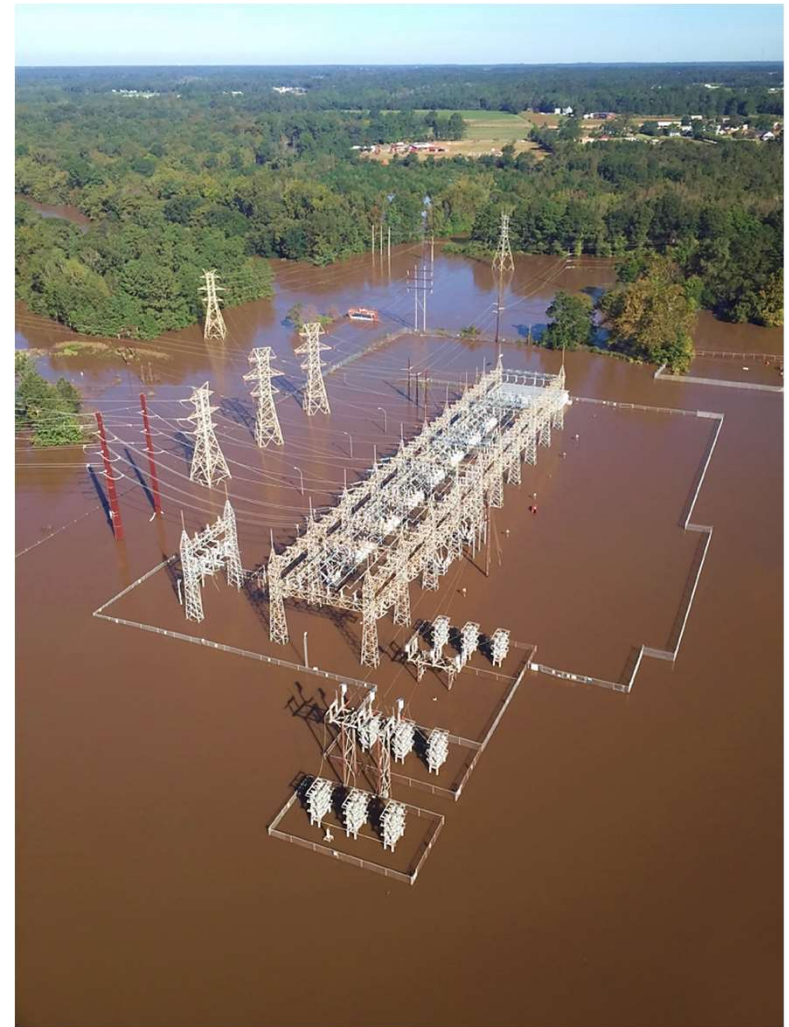
PROGRAM: DISTRIBUTION HARDENING & RESILIENCY – FLOOD HARDENING



GOLDSBORO FLOODING DURING HURRICANE MATTHEW



FLOODING OF A SUBSTATION IN
GOLDSBORO FOLLOWING
HURRICANE MATTHEW (2016)



PROGRAM: SMART METERING INFRASTRUCTURE



The Smart Meter program is a metering solution (meters, communication devices and networks, and back office systems) used to create two-way communications between customer meters and the utility.

DESCRIPTION

Smart meters are digital electricity meters that have advanced features and capabilities beyond traditional electricity meters. Some of the advanced features include the capability for two-way communications, interval usage measurement, tamper detection, voltage and reactive power measurement, and net metering capability.

Duke Energy's standard smart meter system utilizes a radio frequency ("RF") mesh architecture, which is flexible in that the meters within the mesh network establish an optimized RF communication path to a collection point either through other meters, through network range extenders, or via a direct cellular connection.

GRID CAPABILITIES ENABLED

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- ✓ INCREASE AUTOMATION
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- ✓ EXPAND CUSTOMER OPTIONS AND CONTROL

VALUE TO OUR CUSTOMERS

- ✓ MAINTAIN REASONABLE RATES
- ✓ IMPROVE RELIABILITY, SAFETY, RESILIENCY
- ✓ MEET OR EXCEED CUSTOMER EXPECTATIONS

WHERE IT FITS IN OUR PLAN

MODERNIZE by leveraging enterprise systems and technology advancements

PROGRAM: SMART METERING INFRASTRUCTURE





PROGRAM: ELECTRIC TRANSPORTATION

The Electric Transportation effort is a proposed pilot program for South Carolina that will focus on advancing adoption of electric transportation in the State.

DESCRIPTION

The program will establish a foundational level of fast charging infrastructure and determine best practices for cost-effective integration of various electric vehicle types. It will also serve to financially support the deployment of electric school and transit buses in conjunction with the 2016 Volkswagen settlement agreement.

The program will also allow system planners to assess the impacts of charging different types of electric vehicles, as well as impacts that various charging configurations have on the electric system.

In addition to evaluating grid impacts, the Electric Transportation pilot program will assess how all utility customers can benefit from increasing adoption of electric transportation. The pilot program will consist of five components: (1) Residential EV Charging Rebate, (2) Electric Vehicle School Bus Program, (3) Electric Vehicle Transit Bus Program, (4) DC Fast Charging Infrastructure Program, and (5) Education and Outreach.

Another benefit to advancing electric transportation is improved air quality by displacing hydrocarbon based fuels and lowering emissions.

GRID CAPABILITIES ENABLED

- ✓ ACCOMMODATE TWO-WAY POWER FLOWS
- ✓ INCREASE HOSTING CAPACITY
- ✓ MODERNIZE GRID OPERATIONS & PLANNING
- ✓ EXPAND CUSTOMER OPTIONS AND CONTROL

VALUE TO OUR CUSTOMERS

- ✓ MAINTAIN REASONABLE RATES
- ✓ IMPROVE RELIABILITY, SAFETY, RESILIENCY
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WHERE IT FITS IN OUR PLAN

OPTIMIZE the total customer experience

PROGRAM: ELECTRIC TRANSPORTATION



MORE ABOUT THE PROGRAM

In 2011, Duke Energy conducted a plug-in electric vehicle charging station pilot in DEC. This pilot provided charging stations and up to \$1,000 credit toward installation for customers who bought or leased a plug-in electric vehicle. Duke Energy analyzed the distribution impact and ways to mitigate those impacts as electric vehicles come into its service territory; the technical capabilities that the charging stations can offer to help mitigate those potential impacts; and when, where, how long, and how often a customer charges their electric vehicle.

Fast Charging Deployment Needed for Market Growth

Electric vehicles are coming to South Carolina as sales growth through the end of 2017 continued with a compound annual growth rate of 43% since 2011. Lack of charging stations is commonly cited as a barrier to purchasing an EV. The program estimates that approximately 1,000 public direct-current fast charging ("DCFC") plugs will be necessary by 2025 to support current forecasts of EV market growth. Currently, there are only 40 open-standard, publicly available DCFC plugs in South Carolina.

Volkswagen Environmental Mitigation Trust

In 2016, Volkswagen agreed to spend up to \$14.7 billion to settle allegations of cheating emissions standards. Of that amount, \$2.9 billion was used to establish an Environmental Mitigation Trust, which states and U.S. territories may use to invest in transportation projects that will reduce NOx emissions. Of that amount, \$34 million was allocated to South Carolina as a beneficiary under the Settlement Trust. In April 2018, the SCDOT announced the release of the first draft of the state's Beneficiary Mitigation Plan ("BMP"). Eligible mitigation actions under the BMP include replacing or repowering diesel school buses, shuttle buses, or transit buses. In addition, beneficiaries may utilize up to 15% of their total allocation on costs relating to light duty, zero-emission vehicle supply equipment.

Other States Are Embracing Electric Vehicles

The Florida PSC approved an EV Infrastructure Pilot proposed by DEF, including public Level 2 and DC Fast Charging; in New York, ConEdison is supporting the deployment of electric school and transit buses, planned fast charging networks, and residential customer charging research. In Orlando, Florida, the Orlando Utilities Commission has deployed one of the largest municipal EV infrastructure programs in the country. Other examples of states that have embraced EVs in a pilot or otherwise include Maryland, Massachusetts, Oregon, Kentucky, Ohio, and California. Georgia Power has installed 25 public fast charging stations, facilitating EV adoption across the state of Georgia. By installing DC Fast Charging stations in South Carolina, the ET Pilot would build on this neighboring network and allow EV drivers to seamlessly traverse South Carolina along the crucial I-85, I-95, and I-26 interstate corridors.

PROGRAM: ELECTRIC TRANSPORTATION



PROGRAM: CUSTOMER DATA ACCESS



The Customer Data Access program focuses on preparing key data systems for sharing data in a manner that aligns with prevailing data access protocols such as the Green Button standard.

DESCRIPTION

Currently, the Company offers a method for customers to download their trailing energy usage data into an XML format. The Customer Data Access program will incorporate modern data access protocols such as the current **“Green Button-Download My Data”** functionality.

“Green Button-Connect My Data (CMD)” is a regular automatic transfer of a customer’s interval usage data to a third party upon authorization by the customer. The Customer Data Access program will evaluate deployment of CMD or functionality like CMD based on several factors and requirements relevant to South Carolina customers and stakeholders.

GRID CAPABILITIES ENABLED

- ✓ EXPAND CUSTOMER OPTIONS AND CONTROL

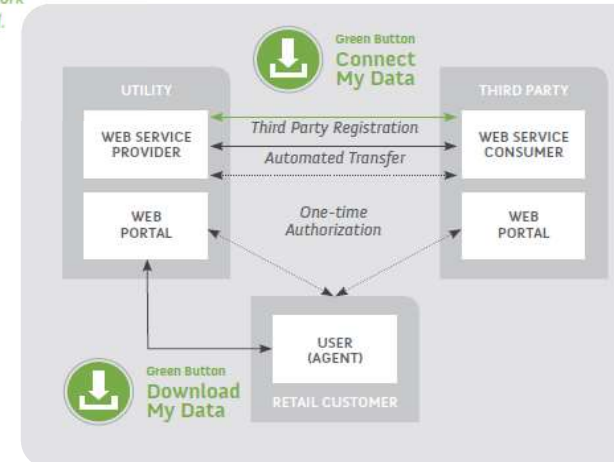
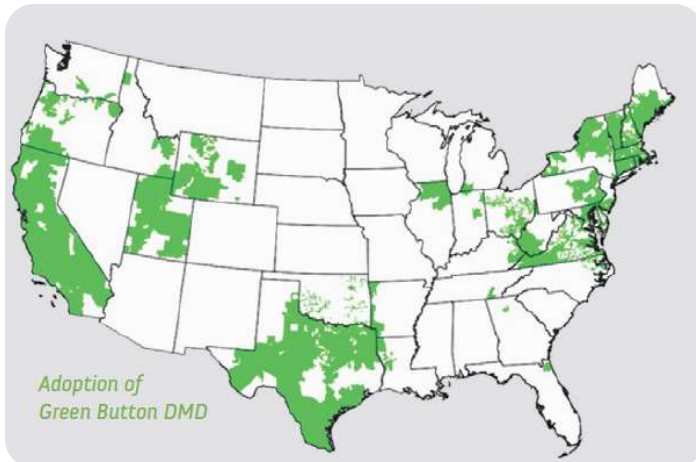
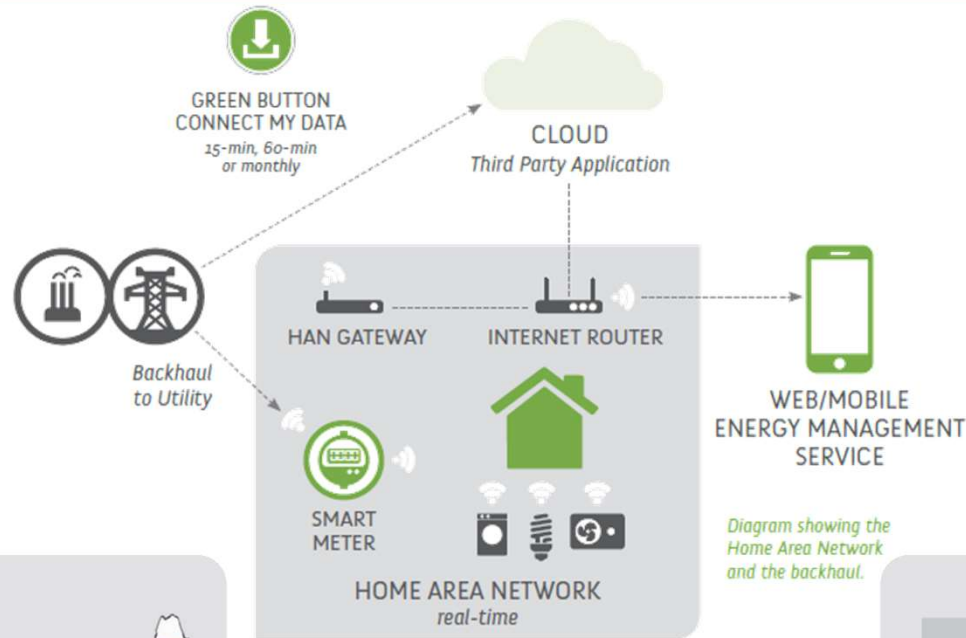
VALUE TO OUR CUSTOMERS

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WHERE IT FITS IN OUR PLAN

MODERNIZE by leveraging enterprise systems and technology advancements

PROGRAM: CUSTOMER DATA ACCESS



Source: Murry, M. and Hawley, J., Got Data? The Value of Energy Data Access to Consumers. More Than Smart. January 2016. <Retrieved from <http://www.missiondata.org/s/Got-Data-value-of-energy-data-access-to-consumers.pdf>>



PROGRAM: TRANSMISSION SYSTEM INTELLIGENCE

The Transmission System Intelligence program deploys transformational system monitoring and control equipment to enable faster response to outages and more intelligent analysis of issues on the grid.

DESCRIPTION

Transmission grid automation improvements will reduce the duration and impacts associated with transmission system issues.

Improvements in transmission system device communication capabilities enable better protection and monitoring of system equipment. The data collected from intelligent communication equipment helps better assess and optimize transmission asset health.

The Transmission System Intelligence program includes 1) the **replacement of electromechanical relays** with remotely operated digital relays, 2) the implementation of **intelligence and monitoring technology** capable of providing asset health data and driving predictive maintenance programs, and 3) the deployment of **remote monitoring and control** functionality for substation devices, and rapid service restoration.

GRID CAPABILITIES ENABLED

- ✓ INCREASE MONITORING & VISIBILITY
- ✓ INCREASE AUTOMATION
- ✓ IMPROVE RELIABILITY
- ✓ ACCOMMODATE TWO-WAY POWER FLOWS
- ✓ MODERNIZE GRID OPERATIONS & PLANNING

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PROGRAM: TRANSMISSION SYSTEM INTELLIGENCE



MORE ABOUT THE PROGRAM

System Intelligence and Monitoring

This subprogram focuses on a machine-learning platform that can determine when equipment maintenance or repair is needed. Health and Risk Monitoring (HRM) of the transmission system allows asset managers to proactively address equipment issues before catastrophic equipment failures occur. The HRM platform utilizes Condition Based Monitoring (CBM) – the continuous remote monitoring of asset health data which is used to extend asset life or execute mitigating activities to prevent equipment failures. HRM supplements CBM data with information from Digital Fault Recorders (DFR), which record the details of transmission system faults to support the types of post-fault event analysis that drives future system performance improvements.

Electromechanical to Digital Relays

This subprogram replaces noncommunicating electromechanical and solid state relays with digital relays. Modern relay design with communications capabilities and microprocessor technology enables quicker recovery from events than the design of the existing electromechanical relays. One digital relay is capable of replacing a variety of legacy single-function electromechanical relays. Two-way communications and event recording capabilities allow them to provide device performance information following a system event to support continuous system design and operational improvements. Additionally, they identify line fault locations, which is the ability to use device data to calculate the distance down a line to a line fault, rather than manually assessing and patrolling transmission lines.

Remote Substation Monitoring

This subprogram enables operators to remotely monitor and control substations. This includes the installation or upgrade of supervisory control and data acquisition system (SCADA) interfaces for substation devices, called remote terminal units (RTUs), and upgrades to associated data communication channels. This subprogram is a critical enabler for programs like Integrated Volt/Var Control and Distribution Automation. This subprogram also upgrades serial communication to IP communication for existing RTUs to collect more data and support more devices.

Remote Control Switches

This subprogram replaces non-communicating switches with modern switches enabled with SCADA communication and remote control capabilities. Transmission line switches are currently manually operated in most substations and cannot be remotely monitored or controlled. Switching, a grid operation often used to section off portions of the transmission system in order to perform equipment maintenance or isolate trouble spots to minimize impacts to customers, has historically required a technician to go to a substation and manually operate one or more line switches. This subprogram increases the number of remote controlled switches to support faster isolation of trouble spots on the transmission system and more rapid restoration following line faults.

PROGRAM: TRANSMISSION SYSTEM INTELLIGENCE



PROGRAM: TRANSMISSION HARDENING & RESILIENCY (H&R)



The Transmission (H&R) program works to create a stronger and more resilient transmission grid capable of withstanding or quickly recovering from extreme external events, natural or man-made.

DESCRIPTION

Each Transmission H&R sub-program works to address unique challenges in ways that harden the system, and not only minimize impacts to customers, but enhance their electric service experience. The **44-kV System Upgrade** subprogram both protects the 44-kV system from extreme weather, but also paves the way for more DER interconnections by creating additional capacity on the system to transport generation from large scale solar sites. Similarly, the **Targeted Line Rebuild for Extreme Weather** subprogram protects some of the higher voltage transmission lines from extreme weather by addressing vulnerable wooden structures.

The **Networking Radially Served Substations** subprogram builds in more resiliency to the transmission system by creating alternative ways to provide customers with reliable electricity supply in the case of an issue with the primary transmission feed; and, the **Substation Flood Mitigation** subprogram builds in protection for substations most vulnerable to flood damage. Altogether, these H&R efforts not only enhance the functionality of individual assets, but substantially improve the overall functionality of the system, particularly under extreme weather conditions. The long-term plan for hardening and resiliency is to relocate or strengthen at-risk assets or other solutions such as raising the flood plane at that site.

GRID CAPABILITIES ENABLED

- ✓ IMPROVE RELIABILITY
- ✓ HARDEN FOR RESILIENCY
- ✓ IMPROVE PHYSICAL SECURITY

VALUE TO OUR CUSTOMERS

- ✓ MAINTAIN REASONABLE RATES
- ✓ IMPROVE RELIABILITY, SAFETY, RESILIENCY
- ✓ MEET OR EXCEED CUSTOMER EXPECTATIONS

WHERE IT FITS IN OUR PLAN

OPTIMIZE the total customer experience

PROGRAM: TRANSMISSION HARDENING & RESILIENCY (H&R)



MORE ABOUT THE PROGRAM

44kV System Upgrades

Rebuilds and upgrades targeted portions of the 44-kV system to both harden the system against extreme weather, position the system to support DER, and make the overall system more resilient. This will be accomplished in three phases:

- PHASE I (infrastructure upgrades): structurally rebuilds the system, replacing wood structures with taller/stronger steel or concrete structures to better withstand damage in extreme weather conditions. Rebuilding 44-kV lines to 100-kV standards improves performance due to greater elevation and clearance from vegetation. The increased conductor spacing between each of the phases and the addition of basic insulation decreases impacts of lightning events.
- PHASE II (voltage conversions): converts specific circuits of the 44-kV system to 100-kV, making them more capable of supporting large scale solar, storage and other DER. These conversions also require converting the substations served by these lines, which generally involves installing high rated equipment such as transformers and breakers. Portions of the 44-kV system, particularly in rural areas that are prime locations for utility scale solar development, are capacity constrained and unable to support additional interconnections.
- PHASE III (circuit looping): builds in circuit ties between upgraded and converted circuits. This creates a looped circuit design capable of feeding power to these circuits from other sources, as needed, to provide additional system resiliency.

Networking Radially Served Substations

Increases resiliency of radially served substations where outage duration is higher than average, including: networked lines sectionalized into separate radial lines, and lines designed as radial feeders. Networked radial lines can be re-networked by replacing the conductor with higher ampacity and by upgrading the protective relaying. Lines designed as radial feeders will be networked to existing lines into another substation. Substations served by networked transmission lines can be served from either end of the line and the line can be sectionalized to isolate an interruption and restore the majority, if not all, of customers before the full line is restored.

PROGRAM: TRANSMISSION HARDENING & RESILIENCY (H&R)



MORE ABOUT THE PROGRAM

Substation Flood Mitigation

Systematically reviewing and prioritizing substations at risk of flooding to determine the proper mitigation solution, which may include elevating or modifying equipment in substations or relocating substations altogether.

Targeted Line Rebuilds for Extreme Weather Events

Specific transmission lines require rebuilding to withstand extreme weather (including wind and ice) and mitigate the risk of unplanned outages. Lines are targeted based on risk-advised decisions along with selection criteria including: tower height, tower condition, and age of asset. Proactive replacement of wooden poles to steel poles that comply with the National Electrical Safety Code (NESC) achieve benefits such as protecting extreme weather and reducing O&M costs.

PROGRAM: TRANSMISSION HARDENING & RESILIENCY (H&R)



TRANSMISSION POLE REPLACEMENTS



69 KV WOOD POLE CONSTRUCTION



NEW 69 KV STEEL POLE CONSTRUCTION



PROGRAM: TRANSFORMER BANK REPLACEMENT

The Transformer Bank Replacement program leverages new system intelligence capabilities to target transformers before they fail.

DESCRIPTION

Predictive and proactive replacement programs like Transformer Bank Replacement significantly reduce the impacts and costs of replacement when compared to performing the same work following a catastrophic failure.

The objective of this program is to anticipate future transformer failures and replace those transformers in an orderly fashion, avoiding the cost and customer outage minutes associated with these failures. Catastrophic failures often result in significant oil spills, requiring expensive cleanup and other mitigation. Proactive replacement also reduces contingent material inventory needed, since replacements have a 12-24 month manufacturing lead time.

GRID CAPABILITIES ENABLED

- ✓ INCREASE MONITORING & VISIBILITY
- ✓ INCREASE AUTOMATION
- ✓ IMPROVE RELIABILITY
- ✓ MODERNIZE GRID OPERATIONS & PLANNING

VALUE TO OUR CUSTOMERS

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WHERE IT FITS IN OUR PLAN

OPTIMIZE the total customer experience



PROGRAM: OIL BREAKER REPLACEMENT

The Oil Breaker Replacement program identifies and replaces oil-filled circuit breakers on the transmission and distribution systems with modern technology.

DESCRIPTION

The purpose of this program is to replace these legacy assets with breaker technology capable of two-way communications and remote operations.

Transmission level oil breakers will be replaced with the modern sulfur hexafluoride gas (SF₆) circuit breaker technology. The medium voltage distribution level oil-filled breakers will be replaced with modern vacuum circuit breaker technology.

The new communication and control capabilities of this modern technology better positions the transmission and distribution systems to work with grid automation systems to better respond to electric grid events. Looking forward, these fast-response gas and vacuum breakers are better suited for protecting circuits with higher solar and other variable energy resource penetration.

GRID CAPABILITIES ENABLED

- ✓ INCREASE MONITORING & VISIBILITY
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VALUE TO OUR CUSTOMERS

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OPTIMIZE the total customer experience



PROGRAM: PHYSICAL & CYBER SECURITY

The Physical and Cyber Security program protects against the potential risks and impacts of attacks on the electric grid.

DESCRIPTION

The program focuses on hardening above the standard compliance requirements. Transmission elements of the program include:

- **Transmission substation physical security**
- **Windows-based change outs** to address cyber security standards for older Windows-based relays.
- **Cyber security enhancements for non-bulk electric system substations**
- **Electromagnetic Pulse and Intentional Electromagnetic Interference (EMP/IEMI) Protection**

At the distribution system level, much of the focus involves securing and improving risk mitigation of remotely controlled field equipment. An example is enabling door alarms and entry notifications. Programs include:

- **Device Entry Alert System (DEAS)**
- **Distribution Line Device Cyber Protection**
- **Secure Access Device Management (SADM)** - a single tool to remotely and securely perform device management activities and event record retrieval on the entire transmission and distribution device inventory.

GRID CAPABILITIES ENABLED

- ✓ HARDEN FOR RESILIENCY
- ✓ IMPROVE CYBER SECURITY
- ✓ IMPROVE PHYSICAL SECURITY
- ✓ INCREASE MONITORING & VISIBILITY
- ✓ INCREASE AUTOMATION
- ✓ IMPROVE RELIABILITY

VALUE TO OUR CUSTOMERS

- ✓ MAINTAIN REASONABLE RATES
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WHERE IT FITS IN OUR PLAN

PROTECT to reduce threats to the grid

PROGRAM: PHYSICAL & CYBER SECURITY



MORE ABOUT THE PROGRAM

Transmission Substation Physical Security

This subprogram enhances the grid resiliency as part of the overall Transmission Security program. Tier 1 site enhancements include high security perimeter fencing and lighting, intrusion detection technology, new security enclosure buildings, hardening of existing control houses, security cameras, and access control. Tier 2 site enhancements include high security perimeter fencing and lighting.

Windows-based Unit Change Outs

The Windows-based Unit Change Outs effort replaces older Windows-based relays that cannot be upgraded due to technology constraints (such as insufficient memory or relay condition). Following these upgrades, the new devices will operate in a Linux environment and be compliant with standards.

Cyber Security Enhancements for non-BES

Cyber Security Enhancements for non-bulk electric system (BES) substations implements protective measures against possible cyber-attacks at those non-BES substations that have Internet-Protocol (IP) routable devices. Such measures include the installation of firewalls and the replacement of vulnerable devices.

EMP/IEMI Protection

Electromagnetic pulses (EMP) and Intentional Electromagnetic Interference (IEMI) can create disruptions for electronic equipment. The measures taken to protect against them focus on hardening and protecting targeted equipment. The electric industry is engaged in significant research, led by the Electric Power Research Institute (EPRI), focused on improving cost-effective and feasible mitigation against EMP/IEMI. This subprogram will focus on pre-scaled implementation of industry research findings.

PROGRAM: PHYSICAL & CYBER SECURITY



MORE ABOUT THE PROGRAM

Device Entry Alert System (DEAS)

The Device Entry Alert System (DEAS) project will install an entry door alarm head-end system and deliver processes to enhance physical and cyber security on the distribution systems' intelligent electronic devices (IEDs). This tool will ensure that all physical access of IEDs and related infrastructure in the field are being tracked and monitored.

Secure Access and Device Management (SADM)

SADM provides a tool to remotely and securely perform device management activities and event record retrieval on our entire device inventory in transmission and distribution. The goal of the project is to improve the security of field devices and increase compliance with North American Electric Reliability Corporation critical infrastructure protection (NERC CIP) and other security requirements.

SADM also provides process and labor efficiencies associated with device management, and improves post-event resolution. Within this program, we will standardize systems and processes for secure remote access to field devices, implement device management tasks (including password management, firmware management, configuration management), manage post-fault and other operational event records, and implement a common solution and support model across all jurisdictions within transmission and distribution.

Distribution Line Device Cyber Protection

The Distribution Line Device Cyber Protection projects address physical and cyber security risks for thousands of SCADA-controlled line devices (e.g., regulators, capacitors, reclosers, etc.). The focus of the projects in this workstream is targeted replacement of legacy control equipment with Enterprise Security and Advanced Distribution Management System compliant equipment. The newer installed equipment meets or exceeds Duke Energy Industrial Control System (ICS) enterprise security requirements and also provides a platform for future asset management enhancements, such as remote firmware and device settings management, reducing the need to travel physically to a site to perform a system upgrade. Examples of equipment being replaced include capacitor and distribution (recloser) control devices.

PROGRAM: PHYSICAL & CYBER SECURITY



COCHRANE FENCE & MAIN ENTRANCE CRASH GATE



PROGRAM: ENTERPRISE COMMUNICATIONS ADVANCED SYSTEMS



The Enterprise Communications program modernizes and secures the critical communications between intelligent grid management systems, data and controls systems, and sensing and control devices.

DESCRIPTION

The program addresses technology obsolescence, secures vulnerabilities, and provides new workforce-enabling capabilities. This program includes improvement and expansion of the entire communications network from the high-speed, high-capacity backbone fiber optic and microwave networks to the wireless connections at the edge of the grid. These upgrades help build the secure communications required for the increasing number of smart components, sensors, and remotely activated devices on the transmission and distribution systems.

Key communication efforts are: (1) **Mission Critical Transport** which strategically upgrades the infrastructure required for high-speed, reliable, sustainable, interoperable communications for grid devices and personnel; (2) **Grid Wide Area Network (Grid WAN)** which improves network reliability, performance and security for current grid management/control applications; (3) **Mission Critical Voice** which replaces current Land Mobile Radio systems with enhanced, reliable, sustainable, interoperable communications across all service territories; and (4) **Next Generation Cellular** which replaces obsolete 2G/3G cellular technology with the more reliable and secure 4G/5G technology required for modern grid devices in the field.

GRID CAPABILITIES ENABLED

- ✓ INCREASE MONITORING & VISIBILITY
- ✓ INCREASE AUTOMATION
- ✓ IMPROVE RELIABILITY
- ✓ ENABLE VOLTAGE CONTROL
- ✓ ACCOMMODATE TWO-WAY POWER FLOWS
- ✓ IMPROVE CYBER SECURITY

VALUE TO OUR CUSTOMERS

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WHERE IT FITS IN OUR PLAN

MODERNIZE by leveraging enterprise systems and technology advancements

PROGRAM: ENTERPRISE COMMUNICATIONS ADVANCED SYSTEMS



MORE ABOUT THE PROGRAM

Mission Critical Transport

Implements the strategic advancements to the backbone of the communication network to ensure reliable, sustainable, interoperable communications for grid devices and personnel. Replaces end-of-life fiber cable, optical systems, and microwave systems; strategically expands high-capacity fiber to new, targeted routes; and investigates alternatives for faster or more cost-effective fiber deployments.

Business Wide Area Network

Updates data network architecture to improve reliability and performance of the core business. Assesses capacity and redundancy requirements and evaluates network options for the core business network and associates area network structures. Supports growing demands for workforce mobility, real-time video capture, data transport needs, and mitigating communication network congestion.

Grid-wide Area Network (Grid WAN)

Improves network reliability, performance and security for grid control, O&M applications by replacing end-of-life data network hardware and converting substations to an IP network architecture. Employs a network redesign, providing capacity and resiliency, and positioning the network to support Field Area Network (FAN) and Neighborhood Area Network (NAN) needed for enabling a smart cities future.

Mission Critical Voice

Strategic replacement and improvement of mission-critical voice (radio) communications to provide reliable, sustainable, interoperable communications for all jurisdictions and businesses. The new radio system will provide increased functionality and interoperability between regions, allowing field workers to use the same radio system to help another region during major storms.

Next Generation Cellular

Addresses the need to migrate 2G/3G communication networks (to be decommissioned by cellular service providers) to updated 4G/5G. Replaces existing network devices located on distribution line devices. In addition to supporting communication continuity through network decommissioning, these upgrades provide greater network bandwidth, lower data latency, and better cybersecurity protection.

PROGRAM: ENTERPRISE COMMUNICATIONS ADVANCED SYSTEMS





PROGRAM: ENTERPRISE APPLICATIONS

The Enterprise Applications program deploys the systems and upgrades needed to monitor the health and security of the grid and analyze data to enable grid automation and optimization technologies.

DESCRIPTION

Upgrades to existing enterprise applications enable system optimization and overall better system performance. Within the program, there are two main components responsible for the delivery of enterprise technology solutions that support transmission, distribution, and other critical lines of business: (1) **Enterprise Systems** and (2) **Grid Analytics**.

This effort focuses on delivering transformative, cross-functional technical solutions to the enterprise in non-disruptive ways. Elements within the portfolio include the Integrated Tools for Outage Applications (iTOA), which works to drive standardization and coordination of grid control center tools and the Targeted Undergrounding (TUG) System, which facilitates efficient workflows via asset management and mapping system upgrades.

Grid Analytics optimizes the electric system health and performance through the deployment of the Health Risk Management (HRM) tool and Enterprise Distribution System Health (EDSH) tool. These tools help to prevent equipment failures and improve asset performance on the transmission and distribution systems, respectively.

GRID CAPABILITIES ENABLED

- ✓ INCREASE MONITORING & VISIBILITY
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- ✓ INCREASE DISTRIBUTED INTELLIGENCE
- ✓ IMPROVE RELIABILITY
- ✓ ENABLE VOLTAGE CONTROL
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- ✓ IMPROVE PHYSICAL SECURITY

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PROGRAM: ENTERPRISE APPLICATIONS



MORE ABOUT THE PROGRAM

Integrated Tools for Operations Application (ITOA)

ITOA is a new platform that optimizes current processes and drives standardization regarding system functionality, work processes, and configuration. This project also upgrades and consolidates outage coordination as well as planned switching and logging applications for transmission and distribution control centers.

Targeted Undergrounding (TUG) System

The TUG System automates manual processes and facilitates faster and more efficient workflow by integrating asset management systems. The product enhances the existing enterprise systems for tracking TUG work and creates new mapping capabilities. The mapping enables visualization of the ongoing targeted underground work and consistency in reporting.

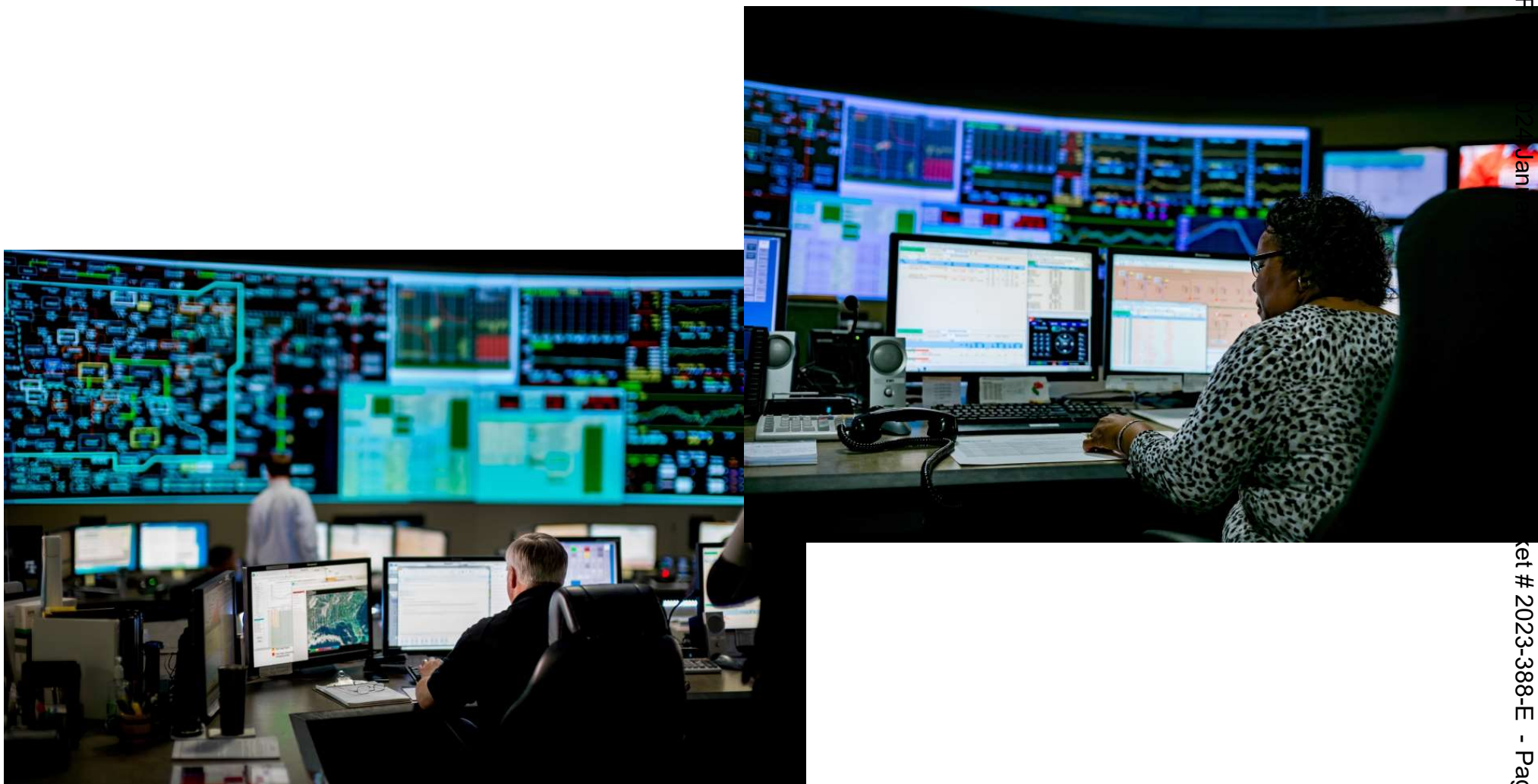
Health and Risk Management (HRM)

HRM will provide a new platform for collecting data and applying analytics optimization for managing transmission system assets. This sub-program will collect and analyze data to improve the management of assets by using predictive and prescriptive analytics and take proactive steps to prevent or mitigate disruptive events..

Enterprise Distribution System Health (EDSH)

EDSH provides a platform that enables PQR&I Planning, Governance, and Customer Delivery to improve reliability and customer satisfaction. It will enable customer-centric reliability planning and provide a basis for optimizing investments using predictive and prescriptive analytics and allow Duke Energy to take proactive steps to prevent or mitigate disruptive events.

PROGRAM: ENTERPRISE APPLICATIONS



PROGRAM: DER DISPATCH ENTERPRISE TOOL



The DER Dispatch Enterprise Tool is a software-based solution that provides operators with the ability to monitor and manage both transmission and distribution connected DERs.

DESCRIPTION

This tool will coordinate with the Distribution Management System (DMS) and Energy Management System (EMS) to improve the way DERs are integrated in the energy supply mix, both at the Distribution and the bulk power level.

By providing system-wide visualization and control of large-scale DERs, the DER Dispatch Tool will enable system operators to model, forecast, and dispatch a portfolio of distributed energy resources, like solar generation, biofuel generation and energy storage, based on system conditions and real-time customer demand. This tool will help meet the need to match energy demand with supply, especially in emergency conditions.

Current processes and tools provide system operators with a rudimentary ability to quickly shed large blocks of solar generation in emergency conditions to meet standards for real power control (BAL-001-2). The proposed solution will provide operators with a more automated and refined toolset to optimize management of both utility and customer owned DERs to meet system stability requirements.

This system will replace an existing tool in DEP that is used to dispatch distribution connected solar in 50 MW increments

GRID CAPABILITIES ENABLED

- ✓ INCREASE MONITORING & VISIBILITY
- ✓ INCREASE DISTRIBUTED INTELLIGENCE
- ✓ ENABLE VOLTAGE CONTROL
- ✓ ACCOMMODATE TWO-WAY POWER FLOWS
- ✓ EXPAND CUSTOMER OPTIONS AND CONTROL

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WHERE IT FITS IN OUR PLAN

MODERNIZE by leveraging enterprise systems and technology advancements

PROGRAM: DER DISPATCH ENTERPRISE TOOL

